1 SOURCE LAW

LOGICAL REASONING – DIAGRAMMING CONDITIONAL LOGIC

Conditional Logic.

The LSAT will test your knowledge of conditional logic in both Logical Reasoning and Logic Games sections. In LSAT terms, conditional logic describes a relationship between two or more conditional occurrences—i.e., an event that will happen upon the occurrence of a separate event. This worksheet will help you understand the basic terms in conditional logic and develop a shorthand for diagramming conditional events.

Definitions.

Sufficient Condition – The "trigger" that necessitates the occurrence of the necessary condition. The sufficient condition is *sufficient* for causing the occurrence of the necessary condition. Nothing else is needed. The sufficient condition appears on the left side of the if-then diagram.

Words to look for: *if, when, every, each, things that, people who,* etc.

Necessary Condition – The occurrence that is conditioned upon the "trigger." The necessary condition *necessarily* occurs upon the occurrence of the sufficient condition. If the sufficient condition exists, then the necessary condition exists as well. The necessary condition appears on the right side of the if-then diagram.

Words to look for: *then, only, only if, must, unless, except, until, without,* etc.

If → Then
Sufficient → Necessary

Insights.

What if you know you have only the necessary condition? *Nothing*. The necessary condition by itself alone tells you nothing. It is not *sufficient* for the occurrence of the sufficient condition—i.e., the sufficient condition's occurrence is not conditioned upon the necessary condition's occurrence. The necessary condition does not trigger anything. For example:

If every student in the class has perfect attendance this week, then we will have cake on Friday.

PA → Cake

Assume we had cake on Friday. Did the students have perfect attendance?

Not *necessarily*. And that's the whole point. Someone else could have brought cake. There could have been another conditional rule we didn't know about that separately triggered the same necessary condition. Or they just wanted cake. The occurrence of the necessary condition by itself tells us nothing else.

Contrapositive: But what about the *absence* of the necessary condition? Assume we did not have cake on Friday. Did the students have perfect attendance? *No*. The absence of cake is the sufficient condition for the absence of perfect attendance. This is called the *contrapositive*. It reverses and negates the conditional logic chain to create an equally valid conditional logic chain.

PA → Cake
becomes
~~Cake~~ → ~~PA~~

This is always true for conditional logic. Let's look at another example:

If Sonia sings the solo, she cannot play piano.
SSS → ~~piano~~
Assume Sonia did not play the piano. Did she sing the solo?

Not *necessarily*. But what if Sonia *played* the piano? Do we know anything else?

Contrapositive:
Piano → ~~SSS~~

Yes! Sonia's playing of the piano is a sufficient condition for the necessary condition that she did not sing the solo. One more example:

Tom works every holiday.
If holiday → Tom working
Contrapositive: if ~~TW~~ → ~~holiday~~

The contrapositive instructs that, if Tom isn't working, it cannot be a holiday.

Unique Unless.

We don't know the proper meaning of the word "unless." Colloquially, the term has lost its formal logic meaning. If someone says to you, "We'll have practice unless it rains," you (and the rest of normal society apart from the LSAC) thinks that means if rain → no practice. Well, according to the LSAC, we're all wrong. This is true, as you will see further below, of *without* and *except* as well.

You are going to have to break a lot of habituated thinking for this one, but we're here to help you. And this will become a fun tool to use to disturb your family and friends. Consider:

We'll have practice unless it rains.

Refer to the definition above for Necessary Condition. *Unless* introduces a necessary condition. This phrase means, in translation, "any instance in which we are NOT having practice, it has rained." So, the true conditional diagram should look like this:

~~practice~~ → rain
and its contrapositive
~~rain~~ → practice

We don't know what happens if it rains. There could exist a reality in which it rains and practice is still occurring. Similarly, we don't know what the weather is like if there is practice. The occurrence of practice tells us nothing about the weather, and the occurrence of rain tells us nothing about practice.

But the absence of practice tells us there is rain, and the absence of rain tells us there is practice. Let's try another one together:

A unless B.

Unless introduces the necessary condition (B), therefore A is the sufficient condition that must be negated:

if not A → B
if not B → A

Mechanical Approach: If you encounter the words *unless*, *except*, *without*, or *until*, get into the habit and following these two steps: (1) the unique signifier word introduces the necessary condition; place it on the right side of the diagram and (2) the NEGATIVE of the other condition is sufficient; so, negate it and place it on the left side of the diagram. Try a few examples:

1.
We have to exercise until we are in shape.
if ~~exercising~~ → in shape
and
if ~~in shape~~ → exercising

2.
All students are attending the field trip except Ron.
if ~~attending~~ → Ron
if ~~Ron~~ → attending

3.
A person cannot thrive without love and care.
if thrive → love and care
[1]if ~~love~~ or ~~care~~ → ~~thrive~~

4.
A dog will die without food.
alive → food
~~food~~ → dead

5.
The show must go on unless there is a fire.
~~show~~ → fire
~~fire~~ → show

[1]We will address multiple conditions more thoroughly below.

Conditional Logic Chains.

The LSAT often tests your knowledge of conditional logic by linking two if-then conditional relationships together to form a third inference.

A → B and B → C therefore A → C
Contrapositive: Not C → Not A

Let's try a more relevant example:

All catapults are siege weapons. Only siege weapons can destroy strong defenses.
This wall—certainly a strong defense—was destroyed. Therefore, a catapult destroyed it.

There is a fallacy in this conditional logic chain. Let's see if we can find it:

catapult → siege weapon	~~siege weapon~~ → ~~catapult~~
[2]destroyed strong defenses → siege weapons	~~siege weapons~~ → ~~destroyed strong defenses~~

The conclusion attempts to take the second relationship (destroyed strong defense → siege weapons) and link it to the first (catapult → siege weapon), but, as you now know, "siege weapons" is the necessary condition of the first and cannot trigger the sufficient condition. So, the conclusion depends upon the assumption that every siege weapon is a catapult (siege weapon → catapult).

Staying with the same first two sentences of the original prompt, what if we changed the second two as follows:

All catapults are siege weapons. Only siege weapons can destroy strong defenses.
No siege weapon has ever entered the Kingdom of Mahalapin.
Therefore, no strong defense in Mahalapin is destroyed.

catapult → siege weapon	~~siege weapon~~ → ~~catapult~~
destroyed strong defenses → siege weapons	~~siege weapons~~ → ~~destroyed strong defenses~~
Mahalapin → ~~siege weapons~~	siege weapons → ~~Mahalapin~~

This conclusion is sound because it creates a conditional logic chain with the contrapositive formed by the second sentence (Mahalapin → ~~siege weapons~~ → ~~destroyed strong defenses~~).

Multiple Conditions and Either/Or.

Multiple Conditions: To form a contrapositive when one of the conditions contains multiple independent elements, you must negate the entire condition AND change the "or" to an "and" or the "and" to an "or." Let's see why:

[2]Refer to the definition of necessary condition above. *Only* is an identifier word.

If it doesn't rain tomorrow, then we will play softball and have a picnic.
~~rain~~ → softball and picnic
Contrapositive: ~~softball~~ OR ~~picnic~~ → rain

The sufficient condition of no rain must yield both parts of the necessary condition (softball and picnic). If either of those two parts is missing, then there must be rain. Let's try again:

My favorite lunch is pizza unless we can have tacos and cake.
~~favorite is not pizza~~ → tacos and cake
Contrapositive: ~~tacos~~ or ~~cake~~ → favorite is pizza

So, we know that, if the school is not serving cake for lunch today (and I can't have it any other way), then my favorite lunch is pizza EVEN IF there is the most delicious taco bar you could ever imagine. The absence of cake is sufficient on its own to make my favorite lunch pizza. But be careful and remember the lessons from above: The presence of both cake and tacos means nothing by itself, but the absence of one does trigger the contrapositive.

Either/Or: Either/or sentences establish unique conditional relationships.

Either Todd or Jamie will pick Katherine up from school.
~~Jamie~~ → Todd
~~Todd~~ → Jamie

Note that this does leave open the possibility that both Todd and Jamie pick Katherine up from school (see how neither doing so alone is sufficient on the left side). In fact, we know nothing about the situation if Jamie is picking Katherine up from school. Compare these insights, however, to the following:

Either Todd or Jamie will pick Katherine up from school, but not both.
~~Jamie~~ → Todd
~~Todd~~ → Jamie
and
Jamie → ~~Todd~~
Todd → ~~Jamie~~

This crucial difference creates a scenario in which one, and only one, of either Todd and Jamie will be picking Katherine up from school. Let's put these two lessons together:

Either (i) Marshall and Gregor or (ii) Dehlia or Yemi will attend the party.
~~Dehlia AND Yemi~~ → Marshall and Gregor
~~Marshall~~ OR ~~Gregor~~ → Dehlia OR Yemi

Again, we know nothing about party attendance if we learn that Marshall and Yemi are present. Remember, all four individuals can be present without breaking the conditions.

Practice Problems.

Now it's your turn. Try out your hand on diagramming the below problems. Draw as many insights as you can (e.g., contrapositives, conditional logic chains, inferences, assumptions, etc.), and be prepared to discuss your findings with your tutor. Remember, this should be challenging, and it is okay if you make some mistakes. We're here to help you through it.

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1.
We have to study until we can no longer keep going.

2.
If there are no ways through, we'll have to make one.

3.
A party isn't fun when the music is too loud.

4.
I can't drive well if it's dark and there are bright headlights.

5.
The only way to be truly happy is to form vulnerable relationships with loved ones.

6.
If I put carrots in the stew, Sam will hate it. If Sam hates the stew, Faisal will become upset.
Faisal is usually not upset unless something has gone wrong.
Does putting carrots in the stew mean something has gone wrong?

7.
Sarah will be Kate's friend if, and only if, Kate shares her toys.

8.
A if B. B if C. Every D is a C. There are Ds unless there are no Es.

9.
Only people who give to others will know true peace.

10.
Only people who aren't selfish can make a difference in politics.

11.
To become a professional athlete, you must be talented and willing to work hard.

12.
To score well on the LSAT, you must study hard or get lucky.

13.
People who are friendly and conscientious do well in this job.
Omar did not do well in this job. Can we conclude Omar was not conscientious?

14.
The store will open when the manager arrives.

15.
Humanity cannot know peace without war.

16.
Either Prya or Joyce will present on Monday, but not both.

17.
People with severe gambling problems will never be happy because they cannot know financial freedom.
Gambling problems cause financial instability for families as well.
People cannot learn how to better themselves until they become happy.

18.
Only by running fast can someone win a race. In 2023, everyone from Fillory won a race.
Not everyone from Fillory is as talented or hard-working as their peers from Asgard.
But no one from Asgard won a race.
Did the competitors from Fillory run fast? Did the competitors from Asgard not?

19.
Those who eat their breakfast perform better in school.

20.
Only those who eat their breakfast perform better in school.